~~Instrumented antifriction bearing and electrical motor equipped therewith~~

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to an antifriction bearing in which a rotating member of the bearing supports an encoder and a nonrotating member of the bearing supports a sensorthat may be used to ~~for the purpose of determining~~ determine ~~certain~~ rotation parameters such as the speed or the angular position of the rotating element supporting the encoder. ~~Such devices find their application in many fields,~~ The present invention also relates to antifriction bearings for use in ~~such as~~ electric motors, ~~in~~ which ~~they~~ are required to operate in severe ~~conditions of~~ speed and temperature conditions.

2. Description of the Relevant Art

~~Through document~~ French Patent No. 2,754,903~~FR-A-2 754 903~~, describes an antifriction bearing ~~is known comprising~~ that includes a sensor ~~integral with~~ on the nonrotating ~~race~~track, of the Hall effect probe type, and an encoder ~~integral with~~ on the rotating ~~race~~ track moving in rotation with a slight air gap relative to the sensor while being capable of producing in the sensor a periodic signal with a frequency proportional to the rotation speed of rotation of the rotating ~~race~~track. The encoder ~~comprises~~ includes an annular active portion. ~~made with~~ The annular active portion includes a plastic magnet and ~~provided with~~ an active ~~zone~~ portion placed opposite the sensor.~~,~~ The active portion may be supplemented by a reinforcement portion ~~consisting of~~ that includes two annular elements placed in contact with the active portion~~,~~ on either side of the active zone.

~~Such an~~This type of antifriction bearing is usually satisfactory, particularly in the field of electric motors. However, this type of encoder cannot operate at ~~high~~ temperatures~~,~~ above 120°. In addition, ~~T~~the sensor and the encoder do not operate satisfactorily if they are subjected to high intensity external magnetic fields, for example the magnetic fields induced by the coils of the stator of electric motors and/or by the electromagnetic brake built into ~~said~~ the motors. Finally, the axial compactness of ~~the~~ this type of antifriction bearing ~~thus instrumented~~ is not optimal and ~~does not make it~~ is not easy to incorporate.

______In high power asynchronous electric motors, ~~the~~ control of the motor requires detection of the rotation parameters of the motor ~~to be detected. Specifically there is a need to know the~~ Knowledge of speed and direction of rotation of the rotor may be needed to ~~be able to~~ adapt the frequency~~, the current~~ and the direction of the current entering the coils of the stator. The use of a multipolar type encoder associated with a Hall effect probe is suitable only for applications in which the power and the control requirements are relatively imprecise, for example for a fan motor that operates at constant speed during use._ ~~Also known are the o~~Optical type sensor encoder systems, such as ~~for example~~ industrial encoders, ~~which are not likely to be built into a motor, which~~ require a mechanical interface for driving by the electric motor and ~~which~~ are relatively sensitive to impacts and to temperature. Optical type sensor encoder systems are not likely to be built into a motor.

______The invention aims to remedy these disadvantages.

SUMMARY

~~The invention proposes~~Herein we describe an instrumented antifriction bearing that ~~is~~ may be axially ~~very~~ compact~~,~~ and may ~~capable of operating~~ operate at high temperatures while delivering precise detection.~~,~~ The antifriction bearing may alsoincluding when they are subjected to intense magnetic fields.

In some embodiments, ~~T~~the instrumented antifriction bearing device~~, according to one aspect of the invention, comprises~~ may include a rotating portion, a nonrotating portion and an assembly for detecting rotation parameters. An assembly for detecting rotation parameters may include ~~comprising~~ an encoder and a sensor. A sensor may be ~~integral~~ integrated with the nonrotating portion and ~~provided~~ may include ~~with~~ a sensor unit. A~~The~~ sensor ~~comprises~~ may include at least one microcoil with a substantially flat winding. A microcoil may be positioned ~~, placed~~ on a support of a circuit mounted in the sensor unit of the nonrotating portion ~~such~~ so that ~~said~~ the microcoil ~~comes~~ may be axially opposite the encoder. This may provides satisfactory axial compactness.

In one embodiment, the device ~~comprises~~ may include a plurality of substantially radial coplanar reception microcoils, which may allow ~~. The sensor may thus achieve~~ substantially precise detection. In ~~another~~ certain embodiments~~ of the invention~~, the device ~~comprises~~ may include a plurality of reception microcoils ~~placed~~ positioned on a plurality of parallel radial planes. ~~This provides a~~ An increased~~greater~~ number of reception coils may provide ~~providing~~ enhanced precision.

~~Advantageously,~~In some embodiments, the device ~~comprises~~ may include a transmission coil ~~placed~~ positioned in the sensor unit. The transmission coil may also be a microcoil.~~,~~ ~~preferably~~ A microcoil may have ~~with~~ a flat winding. ~~Preferably, the~~ In an embodiment, a device ~~comprises~~ may include at least one transmission coil, at least one reception coil, and a data processing circuit ~~placed~~ positioned on the support. These elements ~~can~~ may be used to retain a ~~satisfactory~~ desired axial compactness. The coils may be made ~~in~~ using printed circuit technology. The support may ~~be~~ include a printed circuit substrate in the form of a resin circuit board. ~~In other words, the~~ A sensor ~~comprises~~ may include active

and/or passive elements combined in a single module ~~integral~~ integrated with the nonrotating portion.

~~Advantageously~~In some embodiments, the device may include ~~comprises~~ a plurality of microcoils. Microcoils may be ~~linked~~ coupled ~~together~~ in pairs and/or angularly offset in order to generate a differential signal. The encoder may ~~comprise~~ include an encoder wheel. An encoder wheel may include ~~whose~~ an active zone ~~is~~ made of an electrically conducting metal. In certain embodiments, ~~Advantageously,~~ the encoder ~~comprises~~ may include a printed circuit with ~~whose substrate is~~ an annular~~-in~~ shaped substrate ~~and is provided with~~that includes metallized sectors and nonmetallized sectors. The printed circuit may be mounted on a nonrotating ~~race~~track of the antifriction bearing.

In ~~another~~ some embodiments~~ of the invention~~, the encoder ~~comprises~~ may include an encoder wheel with windows and/or ~~with~~ teeth attached to a rotating ~~race~~ track of the antifriction bearing. The encoder may be ~~made as~~ a substantially solid block. The encoder may be ~~made of~~ pressed sheet metal. ~~Such an~~ An encoder ~~is capable of~~ may ~~operating~~ operate at high temperatures. For the purposes of this application, w~~W~~indows ~~are here intended to mean~~ refer to holes formed in the encoder between two circumferentially continuous portions. For the purposes of this application, ~~T~~teeth ~~are intended to mean~~ refer to portions of material that are ~~integral~~ integrated with a circumferentially continuous portion of the encoder. The encoder may ~~comprise~~ include an axial portion ~~fitted onto~~ positioned on a cylindrical bearing surface of the rotating ~~race~~ track and a radial portion directed towards the other ~~race~~ track and in which the windows or the teeth are formed.

~~For reasons of~~To increase compactness, ~~it is advisable to ensure that~~ at least one portion of the encoder may be positioned ~~is placed~~ in the space situated between the antifriction bearing ~~races~~tracks.~~, that is to say~~ For example, a portion of the encoder may be positioned radially between the cylindrical surfaces of the ~~races~~ tracks which extend between the bearing raceways and the frontal surfaces delimiting said ~~races~~tracks~~,~~ and axially, at right angles to ~~said~~ the cylindrical surfaces, between the rolling elements and the frontal radial surfaces of the antifriction bearing ~~races~~tracks. In ~~another~~ certain embodiments, ~~of the invention,~~ the encoder ~~is placed~~ may be positioned outside the space situated between the antifriction bearing ~~races~~tracks.

In ~~one~~ some embodiments, ~~of the invention,~~ the sensor unit ~~is~~ may be annular. In another embodiment ~~of the invention~~, the sensor unit may occupies an angular sector of less than 360°, for example ~~of the order of~~ approximately 120°. In certain embodiments, ~~In one embodiment of the invention~~, the data processing circuit ~~is~~ may be an application-specific integrated circuit (ASIC).

In some embodiments, ~~The invention also proposes~~ an electric motor may include ~~comprising~~ a rotor, a stator, at least one antifriction bearing supporting the rotor, and a sensor assembly ~~comprising~~ including an encoder and a sensor. The sensor ~~comprises~~ may include at least one microcoil with a substantially flat winding ~~placed~~ positioned on a support of a circuit that is mounted in the sensor unit ~~integral~~ and integrated with the stator such that the microcoil ~~comes~~ is positioned axially opposite the encoder. ~~Usually, the~~In an embodiment, a winding ~~will comprise~~ may include an outer ~~race~~ track integral with the stator and supporting the sensor unit and an inner rotating ~~race~~ track integral with the rotor and supporting the encoder. The motor may be of the high power asynchronous type in which precise control ~~is~~ may be required and facilitated by measuring the rotation parameters precisely. For the purposes of this application, a m~~M~~icrocoil ~~here is intended to mean~~refers to a coil with a winding formed on a circuit.~~,~~ ~~f~~For example, a microcoil may include a copper coil on a printed circuit substrate. The thickness of the card and ~~of~~ the microcoil ~~is of the order of~~ may be approximately 1 mm.

BRIEF DESCRIPTION OF THE DRAWINGS

Features and advantages of the methods and apparatus of the present invention will be more fully appreciated by reference to the following detailed description of presently preferred but nonetheless illustrative embodiments in accordance with the present invention when taken in conjunction with the accompanying drawings in which:

~~The invention will be better understood on studying the detailed description of some embodiments taken as nonlimiting examples and illustrated by the appended drawings, in which:~~

~~– figure~~ FIG.1 depicts ~~is~~ a view of an ~~in~~ axial section of an embodiment of an instrumented antifriction bearing~~, according to one embodiment of the invention~~;

~~– figure~~ FIG. 2 depicts ~~is~~ a partial view of the sensor of ~~figure~~ FIG. 1;

~~– figure~~ FIG. 3 depicts ~~is~~ a frontal view in elevation of the encoder of ~~figure~~ FIG. 1;

~~– figure~~FIG. 4 depicts ~~is~~ a frontal view in elevation of an embodiment of an encoder variant;

~~– figure~~ FIG. 5 depicts ~~is~~ a view ~~in~~ of an axial section of an embodiment of an instrumented antifriction bearing~~, according to another embodiment of the invention~~;

~~– figure~~ FIG. 6 depicts ~~is~~ a frontal view in elevation of the encoder of ~~figure~~ FIG. 5; and

~~– figure~~ FIG. 7 depicts ~~is~~ a wiring diagram of ~~the~~ an embodiment of a sensor.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but

on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

DETAILED DESCRIPTION OF EMBODIMENTS

As illustrated in ~~figure~~ FIG. 1, the rolling bearing 1 ~~comprises~~ may include an outer ~~race~~ track 2~~,~~; an inner ~~race~~ track 3~~,~~; a row of rolling elements 4, ~~here~~ such as balls, placed between the outer ~~race~~track 2 and the inner ~~race~~track 3 and retained by a cage 5~~,~~; a seal 6 on one of its sides;~~,~~ ~~and~~ on the opposite side a speed sensor 5 ~~integral~~ integrated with the outer ~~race~~track 2; and an encoder 8 ~~integral~~ integrated with the inner ~~race~~track 3. In ~~the~~ an embodiments ~~shown~~, the outer ~~race~~track ~~is~~ may be nonrotating and the inner ~~race~~track ~~is~~ may be rotating. ~~However~~In an embodiment, ~~the inverse disposition is perfectly conceivable~~the outer track may be rotating and the inner track may be rotating.

In some embodiments, ~~The~~a sensor 7 ~~comprises~~ may include a detection portion 9 as depicted in ~~illustrated in~~ greater detail in ~~figure~~ FIG. 2.~~,~~ A sensor may include a support unit 10 made of a ~~in~~ synthetic material~~,~~ and a metal element 11 fitted onto a bearing surface of the outer ~~race~~track 2.~~,~~ ~~here in the~~ A groove in a ~~groove~~track ~~usually~~ may be used ~~for~~ to attach~~ing~~ the seal provided in noninstrumented antifriction bearings. A cable 12 may be coupled ~~connected~~ to the detection portion 9 and may be~~is~~ used to transmit information ~~of~~ about speed, ~~of~~ position, and/or or ~~more generally of the~~ rotation parameters. Information may be transmitted to ~~other~~ any units that are capable of exploiting ~~such~~ the data ~~and have not been shown~~.

In some embodiments, ~~The~~ an encoder 8, ~~see~~ as depicted in ~~figures~~ FIGS. 1 and 3, ~~comprises~~ may include a support portion 13 and an operational portion 14. The support portion 13 ~~is~~ may ~~of~~ tubular in shape. The support portion 13 may be positioned on ~~fitted onto~~ a cylindrical bearing surface 3a of the inner ~~race~~track 3 formed between the ~~race~~trackway 3b which is ~~in contact~~ coupled with the rolling elements 4 and a radial surface 3c which forms the end of the inner ~~race~~track 3 in the axial direction on the side of the sensor. The operational portion 14 ~~is~~ may be radial and may include ~~has~~ a plurality of windows 15.~~,~~ ~~of~~ Windows may have a rectangular shape~~,~~ and may be elongated radially ~~and~~ at the large diameter end of the operational portion 14, allowing a continuous circular portion 16 to remain. The operational portion 14 and the support portion 13 ~~are~~ may be~~made in~~ a solid unit~~,~~ and may provide~~ing~~ an economic and particularly robust construction. The encoder 8 may be ~~made from~~ a metal sheet formed by means of pressing and punching steps. ~~It is noticeable~~

~~that the~~ The operational portion 14 ~~is~~ may be slightly recessed relative to the radial surface 3c of the inner ~~race~~track 3. The encoder 8 ~~is~~ may be ~~therefore~~ particularly compact and ~~is placed~~ positioned in the space defined radially between the ~~race~~tracks 2 and 3 of the rolling bearing and axially between the rolling elements 4 and the radial plane through which the end surfaces 2c, 3c of said ~~race~~tracks 2 and 3 pass.

In some embodiments, ~~The~~ a detection portion 9 of the sensor 7 ~~comprises~~ may include a support 17, a transmission microcoil 19, and at least four reception microcoils 20. An ~~on which are mounted an~~ integrated circuit 18, ~~for example of the~~ such as an ASIC type, may be mounted on a support 17 and may be used to ~~which is intended for the~~ process data. ~~processing, a~~A transmission microcoil 19 ~~also called~~ may include an excitation coil. ~~and four reception microcoils 20.~~ The circuit ~~also comprises~~ may include a ~~certain~~ predetermined number of filtering elements such as capacitors, resistors, etc., which are not shown. The detection portion 9 ~~is placed~~ may be positioned axially at a slight distance from the operational portion 14 of the encoder 8 and may occupy ~~occupies~~ an angular sector of ~~the order of~~ approximately 120°~~;~~ while being inserted into the support unit 10, which ~~for its part is~~ may be substantially circular. ~~If necessary,~~ In an embodiment, a continuous angular sector of 360° ~~could be~~ may be provided for insertion of the detection portion into the support unit. The detection portion 9 ~~has a~~ may include a face, oriented facing the encoder 8, that is not substantially covered by the material of the support unit 10 ~~and oriented facing the encoder 8~~.

In some embodiments, ~~The~~ microcoils 19 and 20 ~~are~~ may be ~~of the~~ flat winding types of microcoils. Microcoils ~~and~~ may be ~~of the~~ printed circuits ~~kind~~ or ~~even of the~~ integrated circuits ~~kind~~. The flatness of the windings may provides the sensor 7 with excellent axial compactness. In addition, the reception coils 20 ~~have~~ may have a square outer contour. ~~and are~~ Reception coils may be positioned ~~placed~~ one after the other on the arc of a circle formed by the support 17, while the transmission coil 19 substantially surrounds the reception coils 20 and is shaped like an arc of a circle. The coils 19 and 20 ~~are connected~~ may be coupled to the data processing circuit 18. The coils 19 and 20 may be ~~, itself connected~~ coupled to ~~to~~ the cable 12 ~~in a manner not shown~~.

~~The~~ A metal element 11 ~~comprises~~ may include a portion that forms ~~forming~~ a hook 11a bent into ~~the~~ a groove of the outer ~~race~~track 2 that may be ~~usually~~ used for fastening a

sealing element which, in a noninstrumented antifriction bearing, ~~is conventionally~~ may be substantially symmetrical with the seal 6. The metal element 11 ~~is~~ may be supplemented by a short radial portion directed outward from the portion 11a and an axial portion 11c extending from the free end of the radial portion 11b. ~~and~~ A short radial portion may be in contact on one side with the end radial surface 2c of the outer ~~race~~track 2 and on the other side with the support unit 10 of the sensor 7.~~,~~ ~~and by an~~ An axial portion 11c ~~extending from the free end of the radial portion 11b~~ may ~~which~~ radially surrounds the support unit 10, with the exception of the cable outlet zone 12 where ~~provision is made for~~ the support unit 10 ~~to~~ may extend outward forming a protuberance 21 surrounding the cable 12 and protecting its outlet.

In some embodiments, ~~The~~a support unit 10 may be~~is~~ made of a synthetic material and ~~has~~ may have a generally annular shape with the protuberance 21 projecting over its periphery. ~~and~~ A support unit may have an axial hollow ~~from~~ on its radial face on the side of the antifriction bearing that constitutes a housing for the detection portion 9 while covering ~~it~~ the detection portion on its face opposite the rolling bearing and over its thickness in the radial direction. The support unit 10 and the detection portion 9 ~~are integral~~may be integrated. ~~As a variant~~In one embodiment, the support unit 10 could be metallic.

~~Figure~~ FIG. 4 ~~illustrates~~ depicts an embodiment of an encoder ~~variant~~ in which the support portion 13 is ~~identical~~ similar to ~~that of the preceding embodiment~~ FIG. 3. ~~and the~~The operational portion 14 may be oriented radially outward from the support portion 13. A support portion may be ~~is~~ formed by a plurality of teeth 22, ~~of generally~~ which may be substantially rectangular in shape, elongated radially, whose periphery is circular, and ~~which leave between them~~ crenellations 23 of slightly trapezoidal shape.

~~The mode of operation of the sensor-encoder assembly is similar in both embodiments.~~

The reception coils 20 ~~are~~ may be electrically excited by the transmission coil 19 connected to an oscillating circuit. The transmission coil 19 may generates by induction an electric signal in the reception coils 20. During the rotation of the encoder 8, the windows and the full portions of the operational portion 14 passing before the microcoils may produces a variation of the metal mass situated in front of each reception microcoil 20. In ~~said~~ the reception coils 20, this may results in a variation of the phase of the electric signal induced

due to losses by eddy currents. These variations of the electric signal emitted by the various reception coils 20 and processed by the circuit 18 ~~are~~ may be the basis of the generation of signals representative of the parameters of rotation of the encoder 8, such as the speed of rotation.

In some embodiments, ~~The~~ a sensor with microcoils may allows the instrumented antifriction bearing to deliver reliable information, ~~including~~ even when magnetic fields of high intensity are present. The encoder may be made of an electrically conducting and magnetic metal material, such as steel, or ~~yet~~ electrically conducting and nonmagnetic material, such as aluminum or copper.

~~The r~~Reception microcoils 20 may operate in pairs to deliver a differential signal. The reception microcoils 20 of a pair may be~~are~~ angularly offset by an angle represented by β. ~~and the~~ An angular pitch of the windows is represented by φ. For the signal to be out of phase, ~~requires that~~ one of these angles may ~~should~~ not be a multiple of the other. This therefore gives $\beta \neq a*\varphi$ where a is any integer, the angle β usually being greater than φ. For example this could be $\beta = (a+0.5)*\varphi$ or $\beta = (a+0.25)*\varphi$.

When ~~the~~ an encoder passes in rotation before the sensor, the discontinuities of material of the operational portion 14 may cause periodic variations of the metal mass that is opposite the reception microcoils 20. If there is metal material before each of the coils of a pair of reception coils, the phase difference between the two differential coils ~~is~~ may be zero. If there is metal material before at least one of the two reception coils forming a pair and the metal material is distributed differently before each coil, the losses due to the eddy currents in the metal material ~~will~~ may generate a phase difference of the currents. This phase difference may then be processed and extracted adequately by the processing circuit 18, in order to obtain ~~the~~ desired information, such as ~~the~~ angular speed, ~~the~~ direction of rotation, ~~the~~ position, etc.

In some embodiments, ~~The~~ generation of ~~the~~ an electronic signal ~~does~~ may not ~~therefore~~ depend on the level or the direction of a magnetic field sensed by the microcoils, but on the modification of the currents induced by the excitation coil 19 in the reception coils 20 in the presence of the variations of the electrically conducting metal masses passing before

said microcoils. The signal ~~is~~ may be therefore very insensitive to external magnetic fields, which makes the device according to the invention extremely suitable for operating in an environment subjected to strong magnetic fields such as electric motors. The reception coils 20 ~~are~~ may be distributed on the support 17 with a radial position and angular pitch suitable for cooperating with the operational portion 14 of the encoder 8 and/or delivering the required signals. ~~If necessary,~~ In an embodiment, the number of reception coils 20 may be increased in the circumferential direction and/or ~~stacking of~~ several coils may be stacked in the axial direction ~~may be used~~ in order to obtain higher powered signals.

In some embodiments, s~~S~~ince the microcoils and/or processing circuit 18 ~~are~~ may be extremely thin~~, as is the processing circuit 18~~, the sensor 7 ~~has~~ may have extremely small axial dimensions, which may allow~~ing~~ integration into a sensor unit 10~~ itself having very small axial dimensions~~. Likewise, the encoder may be, due to its structure, ~~be axially extremely~~ thin axially and may be easily integrated into the space ~~lying~~ between the bearing ~~race~~tracks, such that ~~said~~ the encoder does not affect the external dimensions of the instrumented antifriction bearing.

FIGS.~~Figures~~ 5 and 6 ~~show~~ depict and embodiment of ~~a variant with~~ an encoder 8 made with ~~the~~ a printed circuit technique. From a conventional printed circuit substrate coated with a thin metal layer, such as copper~~ for example~~, a disk ~~is made~~ may be made including ~~comprising an alternation of~~ metallized sectors 8a and ~~of~~ nonmetallized sectors 8b. The substrate ~~is~~ may be electrically nonconducting and the metallized sectors 8a ~~are~~ may be electrically conducting.

~~This~~ A disk ~~is~~ may be coupled ~~attached by appropriate means~~ (e.g., by appropriate means, such as fitment and/or bonding) onto an axial portion 3d ~~made for this purpose on~~ the rotating ~~race~~track 3 of the bearing 1. The axial portion 3d may be configured to be coupled to the disk. This type of encoder wheel has little inertia, great axial compactness, and the contours of the active portions may be made with great precision. The aggregate signal ~~is~~ may be ~~therefore~~ particularly weak.

~~Figure~~ FIG. 7 ~~illustrates~~ depicts in greater detail the electrical functions of ~~the~~ an embodiment of the system. ~~It shows that the r~~Reception coils 20 ~~are~~ may be grouped in two

pairs numbered 24 and 25 and framed by dashed lines. For clarity of the drawing, the pairs of reception coils 24 and 25 are shown outside the exciting transmission coil whereas in reality they are inside said transmission coil 19. The coils 19 and 20 ~~are connected~~ may be coupled to the processing circuit 18. The processing circuit 18 ~~comprises~~ may include an oscillator 26, whose output is connected to the transmission coil 19, and two phase demodulators 27 and 28 ~~connected~~ coupled to the output of each of the reception coils 20. In an embodiment, t~~T~~he circuit 18 ~~also comprises~~ may include two interpolating comparators 29, 30, ~~mounted~~ positioned ~~respectively~~ at the output of the phase demodulators 27 and 28. At the output, the processing circuit 18 may transmit~~s~~ a digital signal representative of at least one parameter of rotation of the antifriction bearing, such as ~~the~~ speed, ~~the~~ position, ~~the~~ direction of rotation, ~~the~~ acceleration, etc.

In some embodiments, ~~This is the method of producing~~ an instrumented antifriction bearing may be produced that can be easily integrated into a mechanical assembly due to its small bulk. ~~,~~ The instrumented antifriction bearing may ~~is capable of~~ operate~~ing~~ at high temperatures, such as those existing in an electric motor, and/or ~~capable of~~ operate~~ing~~ in an environment subjected to strong magnetic fields. Through these qualities, the instrumented antifriction bearing according to the invention has worthwhile capabilities for use in a high power asynchronous electric motor. ~~,~~ ~~the~~ The instrumented antifriction bearing ~~being able to~~ may fulfill both the mechanical function of a bearing and the electronic functions of detection necessary to control the motor.

In this patent, certain U.S. patents, U.S. patent applications, and other materials (e.g., articles) have been incorporated by reference. The text of such U.S. patents, U.S. patent applications, and other materials is, however, only incorporated by reference to the extent that no conflict exists between such text and the other statements and drawings set forth herein. In the event of such conflict, then any such conflicting text in such incorporated by reference U.S. patents, U.S. patent applications, and other materials is specifically not incorporated by reference in this patent.

Further modifications and alternative embodiments of various aspects of the invention will be apparent to those skilled in the art in view of this description. Accordingly, this description is to be construed as illustrative only and is for the purpose of teaching those

skilled in the art the general manner of carrying out the invention. It is to be understood that the forms of the invention shown and described herein are to be taken as the presently preferred embodiments. Elements and materials may be substituted for those illustrated and described herein, parts and processes may be reversed, and certain features of the invention may be utilized independently, all as would be apparent to one skilled in the art after having the benefit of this description of the invention. Changes may be made in the elements described herein without departing from the spirit and scope of the invention as described in the following claims.

ABSTRACT

~~The invention concerns an~~ An instrumented ball-bearing may include~~, comprising~~ a rotating part, a non-rotating part, and an assembly for detecting rotation parameters. The assembly for detecting rotation parameters may include ~~including~~ an encoder ~~(8)~~ and a sensor ~~(7)~~. The sensor may be integrated ~~integral~~ with ~~said~~ the non-rotating part. ~~and~~ The sensor may include ~~provided with~~ a sensor unit ~~(10),~~ and ~~with~~ at least a microcoil. The microcoil may have ~~having~~ a substantially planar winding. ~~,~~ The microcoil may be positioned ~~arranged~~ in the sensor unit ~~(10)~~ of the non-rotating part such that the microcoil ~~is urged to~~ may be positioned axially opposite the encoder ~~(8)~~.